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The Poultry Industry 1/

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Breeding

The total number of layers in the United States last year was somewhat less than the number of hens and pullets kept on farms 20 years earlier. The big difference between these years was in the number of eggs produced. Twenty years ago the production was approximately 40 billion eggs, whereas in 1957, production amounted to about 60 billion eggs. Production per bird in 1937 was approximately 99 eggs, in 1947 it was 128 eggs, and 164 eggs in 1957.

Business growth is usually measured by general expansion of its physical plants but such expansion has not materialized in the egg production business. Its growth has centered in the greater inherent capabilities of the birds themselves. One of the major reasons for momentous advance in the production per hen is the method of breeding which has changed from a standardbred in the twenties to strain crossing, crossbreeding, and the crossing of inbreds. In the early thirties it was realized that many fine standardbred stocks had reached a plateau of about 200 eggs per hen annually. Experiments were started at the Agricultural Research Center, Beltsville, Maryland, to determine if some method of breeding in connection with performance, sib-testing and progeny testing would enable the breeder to break this ceiling of 200 eggs. Many methods were tried over a 25-year period with several different breeds and varieties of chickens. Two methods broke through the "ceiling" for a considerable increase in everage production. Standardbred White Leghorns and Rhode Island Reds were carried as controls averaging to lay annually approximately 215 eggs and 209 eggs respectively for the past 10 years. During this same period several different varieties of chickens and methods of breeding were tried and in most cases found to be inferior or

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2/ Section on Sanitation and Disease Control prepared in collaboration with Animal Disease Eradication Division.

about as good as the standardbred controls. Two varieties and two methods of breeding produced superior results. The varieties were the Single Comb White Leghorns and Rhode Island Reds. The methods were crossbreeding and inbreeding. White Leghorn males crossed with Rhode Island Red females produced progeny that averaged, over a 10-year period ending in 1957, 245 eggs annually for the crossbreds and 262 for the incrossbreds.

Research in breeding such as this gave breeders confidence in crossbreeding and incrossbreeding and probably is a major reason for the increase in egg production as a whole. That such research was accepted and used by the producer is shown in some measure by the summary of the breed distribution in National Poultry Improvement Plan hatchery supply flocks. Previous to 1940, the use of crossbreds was negligible and in 1941 - 1942 only two percent of the flocks were crossmated. In 1951 - 1952, there were 14.3 percent and for the first time therewere 3.4 percent of incrossmated flocks. These percentages increased until 1956-57 when they reached 47.1 and 8.0 percent, respectively. Crossbreeding is now not only accepted as a means of improving egg production in poultry but also in cattle and swine for the production of milk and meat, respectively, and for meat production in poultry.

Research work is being continued along these lines in order to find even better varieties for crossing and especially for the production of a superior crossbred producing a white egg. Special emphasis is now being given to strain crosses and for a more positive and less costly means of identifying superior individuals and crosses. This later work includes investigations of blood grouping and hormones.

Nutrition

Practically all of the broilers produced in the United States are grown on commercially mixed feed. Of the estimated 22.5 million tons of formula feed consumed by poultry in 1957, about 7.7 million tons were fed to broilers. Turkeys consumed 2.2 million tons and replacement flocks and laying hens accounted for 12.6 million tons. In 1957, there was an increase in broiler and turkey feed consumption over 1956, and a decrease in consumption by replacement pullets and laying hens. Since more eggs were produced in 1957 than in 1956, this is an indication of a general improvement in feed conversion.

Since it has been shown that high energy diets result in a striking improvement in feed efficiency in both growing and laying chickens, inedible fats have been added to formulated feeds in varying quantities. The quantities added are controlled to a great extent by economic considerations and, at the present time, only small quantities are added because of the comparative high cost of fats. In addition to supplying all of the necessary nutrients in formula feeds, the feed manufacturer is a purveyor of drugs, medicinals and non-nutritive additives. It has been estimated that 8 million tons of formula feed produced in 1955 were medicated, and this figure will probably be doubled in 1958. It has been reported that 16 different medicinals and additives will improve the performance of poultry and a major portion

of manufactured feeds contain some of these materials. They include antibiotics, arsenicals, surface-active agents, coccidiostats, and hormones. This is a rapidly expanding field of investigation which promises new developments. It may even lead to much broader means of disease control.

In addition to supplying nutrients and medicinals, the feed manufacturer and the feed dealer have become suppliers of operating capital for broiler producers. At the present time there are very few growers that are not financed in some manner by different segments of the feed industry. Although it is not as prevalent, there is a trend toward this type of operation among the egg producers.

Along the nutritional front, the most spectacular development in poultry nutrition in recent years is concerned with the energy requirement of poultry and the relationship of energy content of the diet with protein requirements. Although it was demonstrated a number of years ago (Connecticut) that high energy diets gave better growth and feed efficiency, research did not gain much momentum until recently. At the time, this country had an immense supply of inedible fats and means of utilization were sought. Use of fats offered an economical way of increasing the energy content of poultry diets. The research work that followed (Cornell, Maryland, Wisconsin) showed a definite ratio between energy and protein levels in the diet in order to obtain optimum growth and feed efficiency.

The ratio is determined by dividing the calories per pound in the diet by the percentage of crude protein. Studies (Maryland) have indicated that the optimum calorie-protein ratio in diets of growing chicks is about 45:1. However, subsequent work has shown that this ratio is not necessarily a fixed value and that the best ratio is not the same for all conditions. It has been shown (University of British Columbia in Canada) that high fat diets do not increase requirement of choline in the growing chick but do increase the folic acid requirement. Other studies (National Institutes of Health) have shown that increased quantities of B_{12} are necessary in high fat diets.

Contrary to earlier beliefs, it has been demonstrated (Illinois) that the chicken can tolerate very high levels of dietary fat. Studies (Beltsville and Wisconsin) have indicated that laying hens can tolerate a high calorie-protein ratio without any impairment of performance. However, from an economic standpoint, there is probably an optimum ratio.

The question as to whether the 15 percent protein level recommended by the National Research Council in 1953 is adequate with high energy diets and high producing strains has resulted in a series of investigations during the last few years. One report (Texas Experiment Station) has indicated that 18 percent dietary protein was superior to 15 and 13 percent levels in laying diets. A study of the protein requirements during hot weather (USDA Glendale, Arizona Station) showed 15 percent protein to be optimum for all temperatures encountered at the Station. Other results (Beltsville, Cornell, Wisconsin, and Colorado) indicate that a 12 percent protein diet will support optimum egg production. From information presently available there seems to be no reason for increasing the dietary level above 15 percent and considerable evidence has accumulated showing that 12 percent is adequate.

Experiments at Beltsville and other laboratories with diets in which the levels of protein varied from 12 to 18 percent at different energy levels have shown that the protein and energy levels had little or no effect on egg production. There was a striking improvement in feed efficiency as the energy levels were increased.

An important contribution (New Jersey) was made toward closing the wide gap in present knowledge concerning the amino acid requirement of the hen when an entirely synthetic diet was formulated which would support sustained egg production. Using this diet it was possible to determine that 11 amino acids are required for egg production and that glycine, an essential amino acid for the growing chicken, is probably not required.

Results from some laboratories have indicated that with high energy diets the vitamins of the B-complex should be increased over the quantities recommended by the National Research Council, in order to obtain optimum growth and feed efficiency. It has also been reported (Oklahoma) that higher levels of niacin, pantothenic, and folic acid are needed in high energy laying diets for maximum egg production and economy of feed conversion. However, the addition of vitamins of the B-complex in too large an excess to both high and low energy diets resulted in a decrease in egg production (Washington).

New growth factors have been added to the list. A fat soluble material in egg yolk was found to increase the growth and feed efficiency of chicks (Beltsville). Another factor, inorganic in nature, supplied by the ash of various materials, has been demonstrated to improve chick growth (Beltsville, Cornell, Texas). Subsequent work (Texas) has indicated that this factor is molybdenum; however, other laboratories have not been able to verify this finding. An important fundamental finding in poultry nutrition was the identification of the factor that prevented exudative diathesis as selenium (Lederle Laboratories and National Institutes of Health). Also zinc has been found to be an essential element for chick nutrition. (Missouri, Michigan, Commercial Solvents Corporation).

In an entirely new approach to increasing the nutritional value of feedstuff it has been found that water treatment of barley increases its feeding value to approximately that of corn (Washington). It was also observed that feeding enzymes along with barley and oats resulted in considerable improvement in nutritive value of these grains.

Current research in the United States, including Government, State experiment stations, and commercial laboratories, covers many phases of poultry nutrition. Great emphasis is being placed on protein and calorie relationships, both with growing birds and laying hens, with concurrent interest in the metabolism of fats and carbohydrates. Also the effect of the high energy content of diets on requirements and interactions of other nutrients, such as amino acids and vitamins, is receiving considerable attention. Because of recent findings concerning the importance of inorganic sulfate, molybdenum, zinc, selenium, and phosphorus, interest has been revised in research on the metabolism of minerals, particularly trace elements. Work on the characterization of growth factors and search for the presence of still

unrecognized ones is currently in progress in many laboratories. Requirements for amino acids, their metabolism and interaction with other nutrients claim the attention of many nutritionists.

Physiology

Poultry physiology has shared with physiology generally the application of new techniques to its problems. The use of radioisotopes has opened up many possibilities, for example, the analysis of metabolism of the thyroid gland. Considerable progress has been made in our understanding of responses of the bird to specific environmental factors, but no corresponding advance has been made in our knowledge of mechanisms by which effects are mediated. Information on reproductive physiology, particularly in its endocrinological aspects, continues to increase, and some progress has been made toward defining the extent of neural control over ovulation in the hen. The "classical" aspects of physiology have received relatively little attention, although the work at the New Jersey Experiment Station on blood pressure is an exception.

The trend of the poultry industry toward relatively large scale and more concentrated operations has been accompanied by an increasing application of the results of physiology, particularly of environmental physiology, to problems of temperature and humidity control. In some of the larger commercial plants physiologists are working with geneticists and pathologists on problems involving physiological differences between strains or varieties of birds as a basis for selection programs. It is of some interest that two large commercial breeders are using a method developed at the New Jersey Experiment Station for the routine determination of blood pressure as a factor in subsequent mortality and selection. The application of such techniques will undoubtedly expand as the physiological bases of heritable characters become better understood.

There has recently been a revival of interest in the effects of environmental factors on various aspects of poultry production. Even light, the first environmental factor to receive widespread attention, has shared in this revival, particularly in connection with its effect on growth and the attainment of sexual maturity. Problems relating to the physiology of response to extremes of temperature and humidity are under investigation at a number of stations. Much of the work in environmental physiology is perhaps more accurately described as management, housing, etc., but as the responses of birds become better known, it is anticipated that research on mechanisms of response and adaptation will become increasingly important.

Endocrinology, particularly the endocrinology of reproduction, continues to be the most active field in poultry physiology. The controlling influence of the central nervous system on the activity of the anterior pituitary gland is receiving considerable attention, work being in progress or contemplated at the California, Pennsylvania, Illinois, and Cornell Experiment Stations and the Agricultural Research Center. This fundamental work should provide a sound basis for further analysis of reproduction, responses to external and internal factors, and problems involving the physiology of the gonads, adrenals, and thyroid.

Poultry Improvement Programs

Since 1935 there has been in the United States a Federal-State cooperative program known as the National Poultry Improvement Plan. The purpose of this program is to improve the quality of chicks and hatching eggs available to poultry producers through improved breeding and the control of hatchery borne diseases. From the time this program was placed into operation until about 1950, the principal guide used to identify poultry stocks as to breeding quality was the U. S. Record of Performance program. This program is primarily adapted to the closed-flock system of breeding and is still being used by a number of breeders.

Recent developments in poultry breeding have, however, brought about the need for newer methods for evaluating the potential of poultry stocks both for egg and meat production. One of these methods is the use of central random sample performance tests. The original proposal for such tests was made by Hagedoorn of Holland at the Third World's Poultry Congress in Ottawa, Canada, in 1927, but it was not until 20 years later that the first such test was started in California. Since then a number of random sample tests have been established in various locations throughout the country. The majority are egg production tests but there are also several turkey and broiler meat production tests.

Due to the large number of innovations in poultry breeding procedures adopted in recent years, it became apparent that the National Plans could no longer rely on Record of Performance alone as an identifying classification for superior stocks. Therefore, classifications based upon the performance of the progeny of specific stocks in central random sample tests have been adopted by the Plans. Stocks, represented by an entry which meets certain minimum requirements in central random sample tests, are classified as U. S. Performance Tested Parent Stock.

A more recent advance in the field of evaluating stocks produced by the various breeding methods is the multiple-unit random sample test. The principal difference between this type of test and the central random sample test is that all of the entries are tested at several different farm locations. Instead of the usual procedure of having a single sample of 50 birds or a replicated sample of 25 birds each at one location, this test involves the testing of approximately 750 birds divided among five farm locations with two replicate pens on each farm. Only one such test is in operation at the present time. It is being conducted by the Official State Agency for the National Poultry Improvement Plan in Iowa, in cooperation with Iowa State College. The Poultry Research Branch, Animal Husbandry Research Division, is cooperating in the research aspects of this test. The objective is to determine the role of genetic differences as compared to environmental differences in the evaluation of the performance of specific stocks.

Other research on the problem of identifying superior stocks is being directed at methods of evaluating the results of random sample performance tests. Statistical procedures are being sought to determine, for the benefit of prospective purchasers, the significance of differences in the performance of stocks which are commercially available.

The trend is toward fewer but larger and more efficient units in all phases of the poultry industry. As an illustration, we can compare the year 1953 when 4,103 National Plan hatcheries had a combined capacity of 381 million eggs to 1957 when approximately 1,100 fewer such hatcheries had a combined capacity of 384 million eggs. Further evidence of this trend is indicated when flocks and birds tested are considered. The number of flocks tested under the National Plan in 1957 decreased by almost 17,000 from 1953 whereas the number of birds tested in these flocks increased more than 5 million.

There are, no doubt, more well bred chicks available today than ever before. This is due in part to the trend toward a closer industry affiliation between the developmental breeder and the multiplier hatchery.

In the past, most hatcheries purchased only foundation stock from breeders for use in their key flocks. From this stock the hatcheryman produced the birds that went into his hatchery supply flocks from which he produced commercial chicks. Many hatcherymen purchased only cockerels from the breeders for the improvement of their supply flocks. With the advent of the franchise and associate hatchery program, these procedures for poultry improvement are gradually giving way to a program of obtaining all replacements, both males and females, for supply flocks from the foundation breeder each year. This is a necessity since practically all such programs involve a strain cross or hybrid combination which only the originating breeder is able to reproduce in the same combination from year to year. Specialization in breeding for specific purposes has also influenced this trend. This is particularly true in the broiler industry where certain breeders specialize in the production of female lines while others concentrate on breeding male lines which combine well with the female lines of other breeders for maximum meat production efficiency.

Sanitation and Disease Control

A control program on pullorum disease and fowl typhoid is included in the N.P.I.P. and N.T.I.P. for those flocks and hatcheries which participate. From the standpoint of the control of Salmonellas, particularly pullorum and typhoid, the progress has been encouraging. In 1954, 38 million birds were tested for pullorum and typhoid with 89 thousand reactors (.24%), while 3 years later 41 million birds were tested with slightly more than 18,000 reactors (.045%). While this is a voluntary program, approximately 75 percent of all chickens used as breeders are in participating flocks. Other Salmonellas are also considered in the classification of National Plan flocks even though no specific testing programs have been adopted. Present thinking with respect to the control of Paratyphoids seems to be in the direction of improved sanitation.

This sanitation program is proving effective also in reduction in the spread of other egg-borne and hatchery disseminated diseases such as Newcastle Disease, Infectious Bronchitis, Chronic Respiratory Disease, Infectious Sinusitis and Omphalitis.

In spite of the multitude of vaccines, antibiotics, etc., available to control many of these diseases, sanitation is still the fundamental principle of any disease control program.

A Poultry Disease Section has been added to the Animal Disease Eradication Division of the Agricultural Research Service. This Section maintains a staff in Washington, D. C., and has trained poultry disease diagnosticians located in each of the major poultry producing areas. One of the first problems undertaken since the last meeting has been the few isolated cases of ornithosis in turkeys and commercial pigeons. One particular locality has experienced a pathogenic strain of the virus in turkeys. There is no evidence that the disease is egg transmitted. Chemotherapeutic treatment with the tetracycline compounds has suppressed the milder types of the virus. However, repeated treatments in breeder flocks have been disappointing. The virus has been isolated from sea gulls, wild pigeons, and recently from a flock of chickens. There have been a few human cases in turkey processing plant workers, particularly those employees connected with defeathering and eviscerating operations. A Federal regulation, prohibiting the interstate movement of ornithosis infected or exposed poultry, has been in effect since early in 1957.